



Use of Virtual Reality (VR) as an Audio-Visual Distraction Tool in the Reduction of Dental Anxiety during Local Anesthesia

**Jalison Jacob Cheruvatoor^{1*}, Lim Kaini²,
Mohamad Adib Bin Mohd Ali Hanafiah²,
Muhammad Azizuddin Bin Sihabuddin² and Vinay Marla³**

¹*Department of Conservative Dentistry and Endodontics, Penang International Dental College, Penang, Malaysia.*

²*Kementerian Kesihatan Malaysia, Malaysia.*

³*Pratima Clinic, Mysore, Karnataka, India.*

Authors' contributions

This work was carried out in collaboration among all authors. Author JJC designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors LK, MABMAH and MABS managed the analyses of the study and managed the literature searches. Author VM performed the statistical analysis and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i31B31696

Editor(s):

(1) Dr. Takashi Ikeno, National Institute of Mental Health, National Center of Neurology and Psychiatry, Japan.

Reviewers:

(1) Burkay Yakar, Firat University, Turkey.

(2) Rocio Herrero Camarano, University of Valencia, Spain.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/69222>

Original Research Article

Received 02 April 2021

Accepted 08 June 2021

Published 14 June 2021

ABSTRACT

Aims: Dental anxiety is a relatively common problem and it leads to undesirable distresses, such as postponement or avoidance of dental treatment thereby resulting in poorer quality of treatment and reduced oral health related quality of life. Dental anxiety is especially seen in patients undergoing dental injections. To evaluate the effectiveness of audiovisual distraction in the reduction of dental anxiety during la injection.

Study design: Cross-sectional study.

Place and duration of study: Patients visiting Penang International Dental College, Malaysia, between June 2017 and July 2018.

Methodology: A total of 176 patients (88 female and 88 male) requiring endodontic therapy or tooth extraction were recruited for this study. A 14-question long questionnaire using Hamilton anxiety rating scale; and a separate feedback questionnaire was used to evaluate patients' anxiety level and the severity of anxiety symptoms. Paired t-test was used to analyze the data.

Results: There was a significant reduction in the anxiety scores ($p < 0.001$) of the patients following the use of VR distraction during the LA procedure. On an average, the pre-test scores were 1.932 points higher than post-test scores.

Conclusion: Virtual reality could be used as a possible non-pharmacologic means of reducing dental anxiety in patients receiving local anesthesia.

Keywords: Audio-visual distraction; dental anxiety; LA injection; trypanophobia; virtual reality.

ABBREVIATIONS

AV : Audio-visual
HAM-A : Hamilton Anxiety Rating Scale
LA : Local Anesthesia
SPSS : Statistical package for social sciences
VR : Virtual reality

1. INTRODUCTION

Dental treatment procedures can be a traumatic and stressful experience for an individual. This is further compounded by the presence of dental anxiety which can alter the experience of the patient during a dental procedure [1]. Many dental procedures can lead to different levels of stress and anxiety in the patients. Dental anxiety also depends on the age and sex of the individual; and also on the past dental experience [2]. Dental anxiety is one of the common reasons given by many patients for not visiting a dentist or for missing an appointment [3]. Delayed treatments can result in more aggressive treatment procedures leading to overall increased cost to the patient [4].

Various studies have indicated that needles are one of the most important reasons for causing dental anxiety [5-7]. Trypanophobia is an extreme fear of medical procedures involving injections or hypodermic needles. A number of dental procedures requires local anesthesia which is administered using needles [8]. Tooth extraction and root canal treatment are the two most common procedures which falls under this category [7]. We have conducted this study to evaluate the patient perception on the effectiveness of use of virtual reality in the reduction of dental anxiety during local anesthesia.

2. MATERIALS AND METHODS

This is a questionnaire-based cross-sectional study for which approval was taken from the institutional review board. The study was

conducted in Penang International Dental College, Malaysia between January 2017 and December 2018. Sample size was calculated using the G Power software considering 95% power of study and a significance level of 0.05. A total of 176 patients (88 female and 88 male) requiring endodontic therapy or tooth extraction were recruited for this study. Healthy patients between the age group of 18-50, not taking any anti-anxiety drugs or any other medications, and free of any auditory or visual deficits were included in the study. Children and individuals over 50 years of age group, patients suffering from any systemic diseases and patients who did not give consent were excluded from the study.

Before commencement of treatment, the patients were informed about this research and those patients who gave consent were enrolled in the study. The treatment procedure was explained to the patients along with the use of VR device during the LA procedure. The video showed an under-water environment and included a relaxing music. The same video was shown to all the study participants and this was shown for a total of 3 minutes during which the LA procedure was performed. The patient was instructed to raise the left hand slowly in case of any discomfort in which case the procedure would be stopped and the device removed. The Hamilton Anxiety Rating Scale (HAM-A) was used for this study and this was given prior to beginning the treatment procedure [9]. This scale is more generalized and can be used in a variety of settings. The scale consisted of 14 questions. Each item was scored from a scale of 0 (not present) to 5 (severe). Total score was a sum of all 14 questions, with a range of 0 to 56. Results with a score < 17 indicated mild severity, 18-24 mild to moderate severity and 25-30 moderate to severe.

After completing the questionnaire, the patient was given a video eyewear was mounted and the LA procedure performed (Fig. 1). After the



Fig. 1. Use of VR device during LA procedure

treatment was over, the same questionnaire along with a feedback questionnaire was given to the patients. This feedback questionnaire was used to study if the anxiety level reduced after verbal communication and the audio-visual distraction through the VR device. Besides that, it also included questions about family/friends' influences on patient's anxiety. Data was entered into a spread sheet (Excel 2011, Microsoft) and statistical analysis was performed using the Statistical Package for Social Sciences (SPSS). Descriptive statistics were performed and the pre- and post- intervention scores were analyzed using the Paired t-Test.

3. RESULTS AND DISCUSSION

The study included a total of 176 adult participants which comprised of 88 males and females. The anxiety level of each participant

was evaluated using the Hamilton anxiety rating scale before and after exposure to VR. The mean anxiety scores for the study participants upon arrival in the dental clinic was 3.73 which dropped to 1.80 at the end of the procedure. Comparison of these scores using t- test revealed that there was a reduction in the anxiety levels after the intervention. These results were found to be statistically significant (Table 1).

At the conclusion of the treatment procedure, a feedback was taken which included questions related to their experience in relation to the use of VR during the anaesthesia procedure (Table 2). This feedback questionnaire comprised of five questions, in which the participants were asked to choose either 'yes' or 'no'. A majority of the participants (Fig. 2) felt that VR helped them in reducing anxiety due to needle and were willing to use it again in future appointments.

Table 1. Comparison of mean pre- & post- intervention anxiety scores with paired t-test

Variable	Sample Size	Mean Anxiety score	Std. Dev.	Std. error Mean	p value
Pre-Intervention	176	3.73	3.226	.243	<0.001
Post-Intervention	176	1.80	2.54	.192	

Table 2. Participant perception to dental anxiety and effectiveness of VR application in reducing it

Question	Yes	No
Q1. Did the videos help to reduce your dental anxiety	62.1 %	37.9 %
Q2. I would like to wear the video eye wear when I come for treatment next time	59.7 %	40.3 %
Q3. Do you agree that reducing dental anxiety will help to improve patients dental compliance	83.5 %	16.5 %
Q4. Do you think that your family/friends dental experiences influences you	83.5 %	16.5 %
Q5. Do you have any previous traumatic dental experience	13.6 %	86.4 %

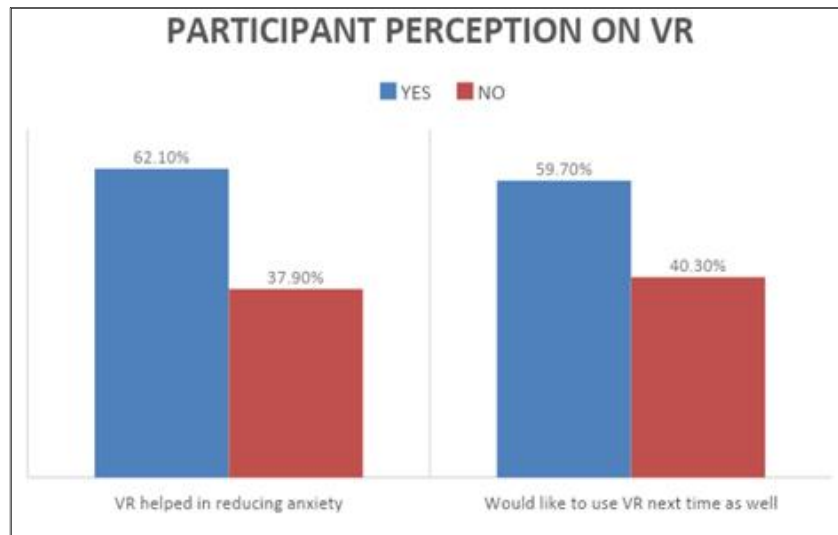


Fig. 2. Participant’s perception on the use of virtual reality (VR) during the LA procedure

Anxiety is a human emotion which causes feelings of apprehension, tension and discomfort. It is an emotional state which precedes the actual encounter and is at times unidentifiable. It is also associated with the thought of visiting the dentist [10]. Dental anxiety is found to be the fifth most common cause of anxiety and has been attributed to a number of factors including previous/traumatic dental experience, influence from peers, individual personal characteristics and others [11]. Dental fear is a reaction to threatening stimuli during dental procedures. Treating anxious dental patients is a challenge

for the dentist due to reduced patient cooperation, increased treatment time and overall unpleasant experience for both the patient and the dentist [10].

Different approaches have been used in the treatment of dental anxiety, such as the use of oral medications, sedation and music distraction. However, the effectiveness of these therapies are less satisfactory. Additionally, the frequent use of oral medications can be expensive and may have their own side-effects [4]. Therefore, a non-invasive approach such as distraction may

be beneficial. Besides, several studies have shown that the use of audio visual (AV) aids in medical practice when used for short invasive procedures to reduce pain and anxiety of patients [12-14]. Nevertheless, there still lies a controversy regarding the effectiveness of AV aids during dental treatment procedures.

Distraction is a non-aversive approach used to modify or reduce a patient's discomfort by distracting his/her attention away from the unpleasant stimulus to accomplish successful treatment [11]. Previous studies have proven that the use of distraction helps to reduced patient's anxiety and in turn decrease their perception of pain sensation, especially during LA injections [15-17]. Our study tested the effectiveness of audio visual and verbal communication in the reduction of dental anxiety during LA injection. VR was used as the audio-visual distraction, while verbal communication involved explaining about the procedures to the patients. In our study, HAM-A questionnaire was used to determine the anxiety level of the patients, before and after wearing the VR device and a feedback questionnaire assessed the patient perception on dental anxiety and on the use of VR. The present study showed that audio visual distraction and verbal communication was effective in reducing dental anxiety during LA injection.

Virtual reality (VR) eyewear is a portable eyewear that has the potential of providing a relaxed environment during dental treatment, especially during LA injection. In contrast to traditional audio visual aids such as television monitor above the patient's chair, this eyewear incorporates visual and auditory feedback which allows the user to immerse oneself in the video, and hence be distracted from unpleasant stimuli. The music in the video also helps to enhance relaxation [11,14]. It has been reported in previous studies that audio visual system is useful in the reduction of pain and anxiety for pediatric patients undergoing dental procedures [15-17]. In our study, the use of VR as an audio visual distraction had a significant impact in reducing dental anxiety during LA procedure. These results suggest that the virtual reality may be a favourable option for patients having dental anxiety associated with other dental procedures as well. The use of VR can also be extended to adult patients who require local anaesthesia and help in reducing their overall dental anxiety and provide a more positive treatment experience. This might inturn have a positive effect on the patient's attendance in a dental clinic and reduce

the number of missed appointments. A study conducted by Buldur and Candan involving children receiving Local Anaesthesia during dental treatment concluded that virtual reality was effective in significantly reducing the pain and anxiety among children [18]. Birang E et al. conducted a study on patients requiring scaling and root planing using VR technology during treatment. The results suggested that there was significant reduction in dental anxiety [19].

Several studies have reported the use of VR to have a desirable effect on pain, anxiety and behaviour during procedures such as treatment of burns, traumatic injuries, dental procedures and injections [15-19]. The mechanism of using the VR system is based on the assumption that pain perception has a large psychological component, and that focusing one's attention on pain would amplify these sensations to the point of feeling extra painful [16]. Conversely, burn patients undergoing treatment experience severe pain even after administering analgesics whereas they only feel a fraction of this pain when they are distracted with VR. It is reported that this is due to the diversion of their attention that manipulates pain perception, thereby changing the way people interpret incoming pain signals, and thus resulting in reduced intensity of pain [13]. By redirection of attention from an unpleasant stimuli to the virtual environment, VR can markedly lessen a patient's subjective pain experience [16].

Based on the patient's perceptions, our study shows that majority of the patients from both genders were willing to wear the eyewear for their future treatment (Fig. 2). Only a small number of patients did not prefer using VR device for treatment. This could be due to personal video preferences as well and needs to be considered in future studies. Few studies have shown that videos related to nature or a game may be effective in creating adequate distraction.

Dental anxiety is a multidimensional concept that can be caused by many factors, such as: fear of pain, personality characteristics, influence of family or friends (vicarious learning), and past traumatic dental experiences which elicit anxiety in a person [17]. Based on our study, the utmost factor influencing patients' dental anxiety was found to be the fear of pain. Around 83.5% of patients reported that influence from family members/friends were also one of the major

factors. The least influential factor was past traumatic dental experiences. This could be due to the fact that majority of our sample size did not face unpleasant dental experiences.

It was suggested that dental anxiety has a direct impact on patients' irregular attendance [1]. Our results suggest that reducing dental anxiety would help in alleviating patients' fear of next appointments and therefore help in improving dental treatment compliance. These results are consistent with previous studies which showed anxious patients tend to find themselves in a cycle of anxiety, irregular attendance and deterioration of oral health. Therefore, reduced dental anxiety will result in better oral health [20].

Studies have shown that patients with traumatic dental experiences have a lower pain threshold and increased pain perception during the next appointment, which results in dental anxiety [1,3,21]. In our study, only 13.6% of the participants gave a history of traumatic dental experiences. Further studies is required to evaluate the effect of VR on patients' anxiety levels who have suffered from prior traumatic dental experiences. However, it can also be argued that use of VR itself would improve a person's initial dental treatment experience and result in overall compliance due to reduced anxiety in future appointments. Our study shows that patient experiencing moderate anxiety changes to mild level after wearing the VR. Similarly, studies have shown that there is a decrease in stress levels in most of the studies using VR distraction [15-17].

Additional advantages for the use of VR include the ease of use, non-invasiveness, budget friendly and most importantly its efficacy in reducing dental anxiety that benefit both the operators and patients. Our, study highlights some of the advantages of VR. However, there were some limitations in our study. We did not have a control group which could have removed any possible biases in terms of reduction in anxiety. Also, we used only one type of video and musical settings in our study. Incorporating variety of visual and music in the VR device would have complicated our study as some studies claim that anxiety reduction may also be related to the type of visual and music employed [14]. Future studies conducted should in such a direction to determine the overall efficacy of VR in reduction of dental anxiety.

4. CONCLUSION

To summarize, our study highlights the effectiveness of audio visual and verbal communication as a desirable way to reduce dental anxiety during LA injection. Further research is required to help in improving this VR system to become a viable form of anxiety control during dental procedures. Such techniques that are proven to be effective in reducing dental anxiety are probably effective in treating other painful procedures as well.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the ethics committee of Penang International Dental College (PIDC/IRB/SRP/6/17) and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Milgrom P, Newton JT, Boyle C, Heaton LJ, Donaldson N. The effects of dental anxiety and irregular attendance on referral for dental treatment under sedation within the National Health Service in London. *Community Dent Oral Epidemiol.* 2010;38(5):453-459.
2. Mohammed RB, Lalithamma T, Varma DM, et al. Prevalence of dental anxiety and its relation to age and gender in coastal Andhra (Visakhapatnam) population, India. *J Nat Sci Biol Med.* 2014;5(2):409-414.
DOI: 10.4103/0976-9668.136210
3. Caltabiano ML, Croker F, Page L, et al. Dental anxiety in patients attending a student dental clinic. *BMC Oral Health.* 2018;18:48.

4. Armfield JM, Heaton LJ. Management of fear and anxiety in the dental clinic. *Australian Dental Journal*. 2013;58:390-407.
5. McLennon J, Rogers MAM. The fear of needles: A systematic review and meta-analysis. *J. Adv. Nurs*. 2019;75:30-42.
6. Armfield JM, Milgrom P. A clinician guide to patients afraid of dental injections and numbness. *SAAD Dig*. 2011;27:33-39.
7. Alaki S, Alotaibi A, Almadadi E, Alanquri E. Dental anxiety in middle school children and their caregivers: Prevalence and severity. *Journal of Dentistry and Oral Hygiene*. 2012;4(1):6-11.
8. Ali FM, Bai P, Dungrani H, Raju MV, Ustad F, Hassan I. Nature and prevalence of needle phobia among dental college patients. *J Dent Res Rev*. 2015;2:130-3.
9. Hamilton M. The assessment of anxiety states by rating. *Br J Med Psychol*. 1959; 32:50-55.
10. Longman L, Ireland R. Management of dental anxiety. *Vital*. 2010;7:22–25.
11. Appukuttan DP. Strategies to manage patients with dental anxiety and dental phobia: literature review. *Clin Cosmet Investig Dent*. 2016;8:35-50.
12. Alves IBS, Granville-Garcia AF, Firmino RT, Gomes MC, Costa EMMdB. The use of audiovisual distraction eyeglasses as a resource in Pediatric dental care: A case series. *RGO-Revista Gaúcha de Odontologia* 2019;67:e20190059.
13. Morris LD, Louw QA, Grimmer-Somers K. The effectiveness of virtual reality on reducing pain and anxiety in burn injury patients: A systematic review. *Clin J Pain*. 2009;25:815–26.
14. Wiederhold MD, Gao K, Wiederhold BK. Clinical use of virtual reality distraction system to reduce anxiety and pain in dental procedures. *Cyberpsychology, Behavior and Social Networking*. 2014; 17(6):359-65.
15. Fakhruddin KS, Hisham EB, Gorduysus MO. Effectiveness of audiovisual distraction eyewear and computerized delivery of anesthesia during pulp therapy of primary molars in phobic child patients. *Eur J Dent*. 2015;9(4):470-475. DOI: 10.4103/1305-7456.172637
16. Prado IM, Carcavalli L, Abreu LG, Serra-Negra JM, Paiva SM, Martins CC. Use of distraction techniques for the management of anxiety and fear in paediatric dental practice: A systematic review of randomized controlled trials. *Int J Paediatr Dent*. 2019;29:650–668.
17. Nunna M, Dasaraju RK, Kamatham R, Mallineni SK, Nuvvula S. Comparative evaluation of virtual reality distraction and counter-stimulation on dental anxiety and pain perception in children. *J Dent Anesth Pain Med*. 2019;19(5):277-288.
18. Buldur B, Candan M. Does virtual reality affect children's dental anxiety, pain, and behaviour? A randomised, placebo-controlled, cross-over trial. *Pesqui Bras Odontopediatria Clin Integ*. 2021;21: e0082.
19. Birang E, Yaghini J, Birang R, Zohary M. Effect of virtual reality during periodontal treatment of patients with anxiety. *J Res Dentomaxillofac Sci*. 2019;4(1):9-15.
20. Armfield JM, Stewart JF, Spencer AJ. The vicious cycle of dental fear: exploring the interplay between oral health, service utilization and dental fear. *BMC Oral Health*. 2007;1-7.
21. Sweta VR, Abhinav RP, Ramesh A. Role of virtual reality in pain perception of patients following the administration of local anesthesia. *Ann Maxillofac Surg*. 2019;9(1):1101. DOI: 10.4103/ams.ams_263_18.

© 2021 Cheruvatoor et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/69222>